What Matters More for Old Age? Vulnerability Assessment using Household Survey of Pakistan

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Abstract: *Vulnerability depends on three risk factors, i.e. exposure to risk, sensitivity towards risk and adaptive capacity. At present there is no standard indicator to analyze the vulnerability of old age in Pakistan. This paper addresses the challenge. The main objective in this paper is to identify how household-specific factors influence old age vulnerabilities. Logistic regression is used for empirical analysis and data is driven from Household Integrated Economic Survey (HIES 2018-19) of Pakistan. The results show that 21% of individuals aged 80 years and above fall into severely vulnerable category, and 34% of 70-80 years of age are moderately vulnerable. It further reveals that older women are more vulnerable than men and urban resident's health status is not promising, with a higher sensitivity status. The findings serve as a reference for identification and effective interventions to address the old age vulnerabilities and design a sustainable social protection system for the old age population.*

JEL Classifications: D69, J12, Z18

Introduction

Vulnerability is a complex and multidimensional concept that includes behavioral, economic, sociocultural and political factors, all of which interact with biological processes throughout an individual's life (Barbosa K.T.F et al., 2017; Marçola A.G et al., 2023). When considering vulnerability in older adults, it reflects the increased risk of harm due to a combination of interconnected risks. These risks include exposure to potential threats, the likelihood of these threats occurring and the individual's ability to defend against them (Slaets J.P., 2006; Marçola A.G et al., 2023). These can be categorized into three key dimensions: state (exposure), threats (sensitivity), and adaptive (coping) capacity, each with its own specific probabilities (Schroder B.E., Marianti R., 2006; Barbosa K.T.F et al., 2017; Ayres J.R.C.M et al., 2012).

In this study vulnerability is examined through primary components of: exposure to covariate shocks (environmental conditions) and a sensitivity that reflects health risks and chronic conditions affecting older adults through total health expenditures. The interaction of differential exposure, varying levels of sensitivity and different coping capacities collectively influence both the likelihood of experiencing adverse outcomes and the severity of these outcomes. These domains interact in ways that can either mitigate or exacerbate vulnerability, contributing to different levels of risk, harm and severity that individuals may encounter. Evidence in gerontology literature shows that vulnerability tends to increase with age, emphasizing the connection between age and the risk

of negative outcomes (Beales D., Tulloch A.J, 2013; Bolina A.F et al., 2018). This study seeks to broaden the understanding of the socioeconomic and health challenges faced by older adults. The scientific literature on this topic is still limited with few population-based studies evaluating the various components of vulnerability in older age (Bolina A.F et al., 2019; Marçola A.G et al., 2023; Beales D., Tulloch A.J, 2013).

As a developing country, Pakistan is experiencing the challenges of a demographic transition, with the proportion of older individuals in the population steadily rising. By 2050, it is projected that 12% of the population will be aged 60 and above amounting to 40 million people (Zainab S. et al., 2021; SPRC, 2022). This rapid demographic shift will likely lead to increased direct and indirect costs for public institutions necessitating improved policy and program planning to promote active and healthy aging (Barbosa K.T.F et al., 2017).

This paper aims to fill the research gap by developing a practical old-age vulnerability index based on the sociodemographic characteristics of households. It considers the uncertainties and shocks associated with economic and health insecurities among older adults, using constructed indexes to reflect their vulnerability. The significance of this study lies in its potential to inform both research and policy development regarding old-age protection through the construction of a comprehensive vulnerability index.

Objective of the Study:

- To determine what types of vulnerabilities old age family members are facing
- To identify what type of HH specific factors influence old age vulnerabilities

Literature Review

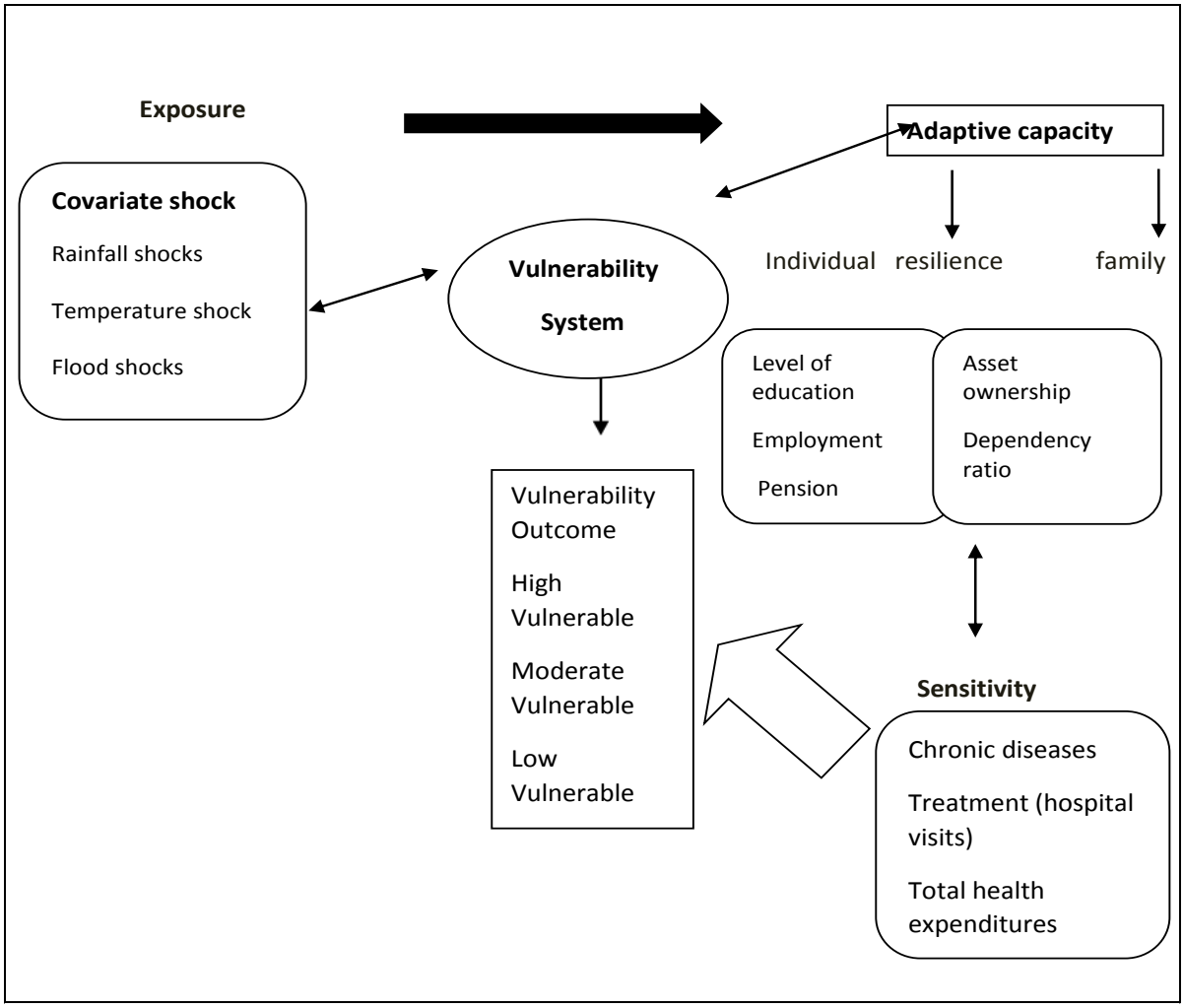
Exposure refers to factors such as marital status or socioeconomic position that influence the likelihood of encountering specific threats or adverse outcomes (Schroder B.E, Marianti R, 2006; Manstead A.S, 2018). In social gerontology and demography life course approaches contribute to the concept of vulnerability by highlighting factors originating earlier in life that strongly correlate with insecurities in old age (Grundy, 2006; Lam J. et al., 2022; Yanguas et al., 2018). Risks are typically classified into two types: covariate and idiosyncratic. Idiosyncratic shocks are those experienced by individual households, such as unemployment, death, or injury that are not shared by neighboring households. Conversely, covariate shocks impact multiple households within the same geographic area, such as natural disasters or epidemics (Krueger et al., 2016; Dercon et al., 2005; Calvo and Dercon, 2005). These shocks can also be categorized based on their origins, including economic, health-related, political, or climatic factors (Clarke D. and Dercon, 2009; Dercon S., 2002). Climatic shocks arise from sudden environmental changes such as floods, droughts, or erosion which impact livestock and crops. Economic shocks involve unexpected changes in a country's economic conditions, affecting individuals' lives, while health shocks, such as illness or death, can have significant economic repercussions for households.

Sensitivity is defined as the degree to which specific events drive individuals toward adverse outcomes, especially when resources to mitigate such events are available (Steverink N., 2001; Crane, M.A 2004). In research, sensitivity often refers to the degree of responsiveness to stress (Ibok O.W et al., 2019). Lorenz K.A (2007) broadens the concept of sensitivity by addressing the discontinuous nature of late-life progression. This concept is particularly relevant for capturing the impact of shocks or crises, such as illness which disrupts daily routines and necessitates the mobilization of coping resources to prevent a decline in well-being (Steverink, N 2001; Crane et al., 2004; Wenger, 1997). Some threats, such as declining physical and health abilities, loss of income, or the death of a spouse or other family members are particularly significant for older adults, as they stem from the biological and social processes of aging (Amarya S., Singh K., & Sabharwal M., 2018). A large segment of the population faces prolonged insecurity and persistent deprivation (Dreze and Sen, 1991). Moreover, these individuals often confront the vulnerability or precariousness of their existence, leading to sudden dispossession or the threat thereof.

Health and autonomy are fundamental needs such as healthcare, nutrition, housing, and physical and economic security deriving from them (Doyal and Gough, 1991). Recent research on aging in Britain has greatly contributed to the concept of vulnerability with studies by Walker E. et al.

(2004) highlighting the importance of social relationships, health, financial resources, safe and pleasant neighborhoods for the well-being of older adults. In developing countries however, research on aging tends to focus more on material outcomes, often overlooking the priorities of older individuals.

Adaptive capacity is a key factor in reducing the vulnerability of a system (Ibok et al., 2019; IPPC, 2007; Polsky et al., 2007). It refers to the assets and relationships that enable people to protect themselves from adverse outcomes or recover from crises. These assets include human capital, household relationships, labor power, productive assets, and social capital (Moser C., 1998; 2006; Abdelhak S., Sulaiman J., & Mohd S., 2012). However, the ability to cope with and reduce vulnerability depends not only on the initial stock of assets but also on the capacity to manage and transform these assets into income, food, and other basic necessities (Moser, 1998; Clodagh & Clare, 2015; Ali I. et al., 2019). A household's response to shocks leads to various outcomes along the old-age vulnerability continuum, classifying households into different vulnerability groups, such as highly vulnerable, moderately vulnerable, and low vulnerable.

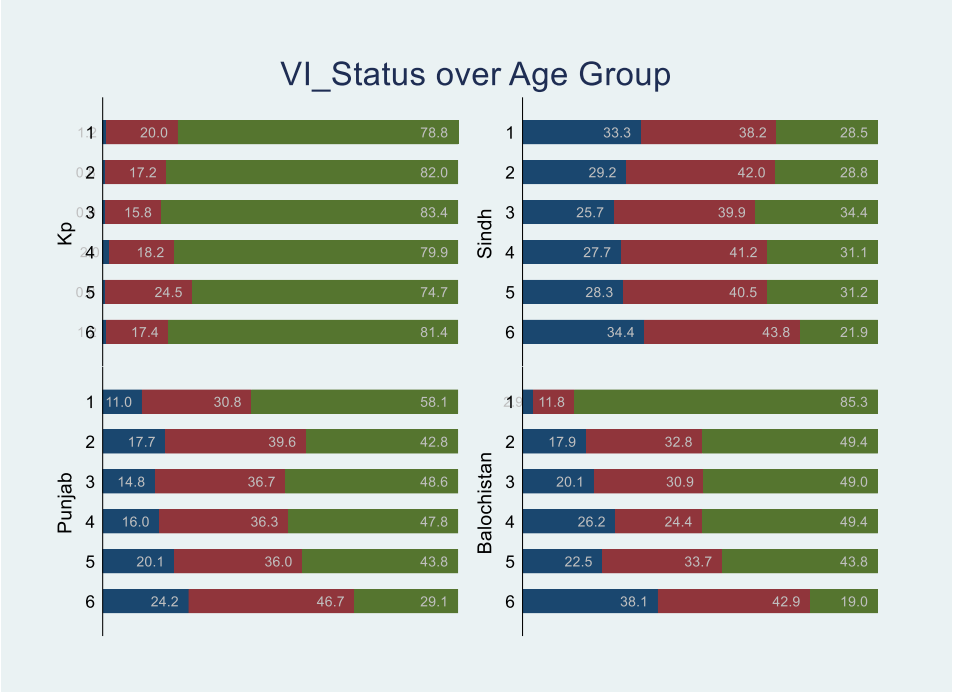


Conceptual framework of vulnerability, constructed by author

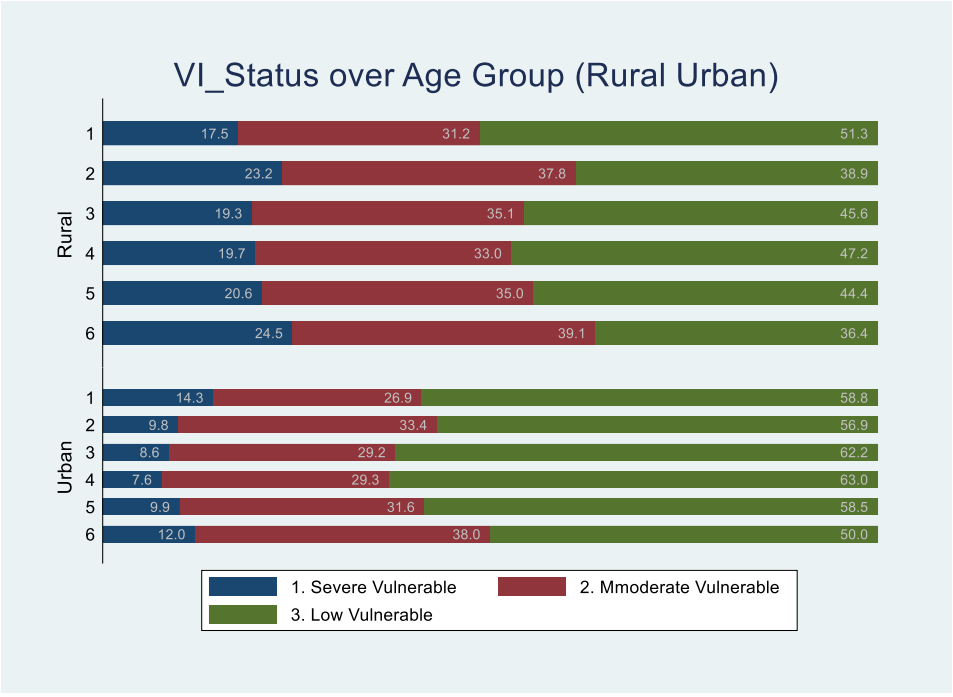
Data Description and Methodological Framework

Section 3.1 discuss the overall situational analysis of old age vulnerability. Table-1 shows the descriptive statistics. In Section 3.3, the determinants of the vulnerability index are analyzed using a logistic regression model. The dataset comprises household-level data and climate-related variables. Household-specific data is sourced from the Household Integrated Economic Survey (HIES) 2018-19, while the climate data is obtained from the Pakistan Meteorological Department (PMD).

Overall Situational Analysis of the Vulnerability for old age



Graph 1: vulnerability distribution of old age categories; province wise



Graph 2: vulnerability distribution of old age categories over region

The graphs illustrates different age groups on the y-axis where 4, 5 and 6 represents age categories of age 60-70, 71-80 and 81-max respectively. The three categories of vulnerability are labeled on the x-axis. The sample includes 48,968 individuals, with 9,301 elderly individuals. In the oldest age group (81 years and above), 38% of individuals in Balochistan fall into the severely vulnerable category, compared to only 1.5% in Khyber Pakhtunkhwa (KP). In Sindh, 33% of younger individuals (16-21 years old) are classified as severely vulnerable. Meanwhile, in Punjab, around 47% of elderly individuals (above age years) are moderately vulnerable. Additionally, 24.5% of elderly individuals of age above 80 in rural area fall into the severely vulnerable category, while 38% of the same age group in urban areas are considered moderately vulnerable.

Table-1 Variables description and summary statistics for age 60 and above

Variables	Description of variables	unit	Percentage (%)
Response variable			
Composite Vulnerability index	The total vulnerability constructed by sum of sensitivity index and exposure index.	Low vulnerable=1 Moderate vulnerable=2 Severe vulnerable=3	18.0 30.4 51.5
Sensitivity Index	The health status of individuals including non-communicable diseases and total health expenditures	Low vulnerable=1 Moderate vulnerable=2 Severe vulnerable=3	43.1 6.2 50.6
Exposure index	Household's vulnerability to covariate shocks	Low vulnerable=1 Moderate vulnerable=2 Severe vulnerable=3	26.3 33.4 40.2
Adaptive Capacity	Resilience of household against total vulnerability	Severe vulnerable=1 Moderate vulnerable=2 Low vulnerable=3	15 33.6 51.2
Explanatory variables			
Age	Respondent of age 60 and above	Years	13%
Region	Binary variable taking value of 1 if reside in urban	Rural=0 Urban=1	65.3 34.6
Gender	A binary variable taking value of 1 for male and 0 for female	Female=0 Male=1	38.4 61.6
Head Employment	Whether individual is employed(full/part time)	Employed=1 Otherwise=0	56.9 43.1
Education	Highest level of education attained	Less than primary= 0 Primary=1 Matric=2 Intermediate=3 Graduation=4 Post-Graduation=5	68.3 2.6 14.6 8.2 6.00 .08
Prevalence of non-communicable diseases	A binary variable showing existence of non-communicable diseases for 60-years and above	Chronic=1 Otherwise=0	26 74
Wealth Quintiles	Five quintiles of wealth ranging from lowest to highest	First Quintile Second Quintile Third Quintile Fourth Quintile Fifth Quintile	17.1 18.4 19.4 19 26

Empirical Model

To examine the factors influencing the sensitivity index, composite vulnerability index and adaptive capacity index, we have used logistic regression model. Below is a detailed explanation of the methodology used in the empirical analysis. We have restrict our sample to HIES 2018-19 only because of availability of 'out of pocket expenditure' data which is not included in previous years surveys.

For a discrete dependent variable, logistic regression is often used to evaluate the relationship between variables, measuring both the magnitude and direction of the correlation. Due to its robust results, it is widely accepted method when dealing with discrete dependent variables (Zhang, G. et al., 2022; Hosmer Jr. et al., 2013; Sperandei, 2014).

Given that our dependent variables are binary (e.g., whether an individual is exposed to severe sensitivity, total vulnerability and has adaptive capacity or not), value of '1' is attributed in this case and '0' otherwise. For construction of dependent variables, the study has used Ibok, Otu W et al. (2019) methodology. The logistic equation specification is expressed as follows:

$$Y_i = \beta_0 + \beta_1(\text{gender})_i + \beta_2 (\text{HH size})_i + \beta_3 (\text{Marital status})_i + \beta_{4i} (\text{age group})_i + \beta_{5i} (\text{education level})_i + \beta_6(\text{region})_i + \beta_{7i} (\text{wealth status})_i + \epsilon_j \quad (3)$$

Where:

- Y_i is dependent variable (Sensitivity Index, Composite Vulnerability and Adaptive Capacity Index).
- β_0 is the intercept and other β_i are the coefficients of the independent variables.

ϵ_j is the error term and is assumed to be independently and identically distributed (iid).

Results

Table 2 displays the relationship between socio-demographic variables and the constructed indexes—Vulnerability Index (VI), Sensitivity Index (SI), and Adaptive Capacity index (ACI)—is examined using a logistic regression. Since the VI, SI, and AC are binary dependent variables, the logit model provided valuable insights into the influence of independent variables on these indexes.

Table 2: Logistic Regression: Average Marginal Effects

Indicators of Vulnerability

Explanatory variables	Sensitivity index	Composite vulnerability index	Adaptive capacity index
Head gender	-0.0271***	-0.0584***	0.158***
(Female=Ref)	(0.00844)	(0.00951)	(0.0125)
Household size	0.00893***	0.0294***	-0.0495***
	(0.000705)	(0.000878)	(0.00123)
Head married	0.0175	0.130***	-0.240***
(unmarried=Ref)	(0.0174)	(0.0195)	(0.0176)
18-35	0.0402*	0.0846***	-0.0850**
	(0.0243)	(0.0291)	(0.0348)
36-59	0.0397	0.0386	-0.0122
	(0.0243)	(0.0291)	(0.0347)
60-70	0.0851***	0.0720**	-0.0426
	(0.0251)	(0.0300)	(0.0361)
71-80	0.0933***	0.118***	-0.219***
	(0.0273)	(0.0323)	(0.0396)
81-max	0.147***	0.199***	-0.233***
(below 18=Ref)	(0.0361)	(0.0411)	(0.0540)
Education			
Primary	0.00595	-0.0251	0.108***
	(0.0141)	(0.0160)	(0.0190)
Secondary	-0.0155**	-0.0654***	0.191***
	(0.00671)	(0.00759)	(0.00884)
Intermediate	-0.0137	-0.0839***	0.281***
	(0.00908)	(0.0103)	(0.0115)
Graduation	-0.0227*	-0.209***	0.445***
	(0.0120)	(0.0140)	(0.0112)
Post-Graduation	-0.0523	-0.401***	0.513***
(non-educated=Ref)	(0.0762)	(0.0692)	(0.0131)
2nd wealth quantile	-0.000617	-0.163***	0.112***
	(0.00717)	(0.00707)	(0.00429)
3rd wealth quantile	0.0296***	-0.315***	0.455***
	(0.00747)	(0.00742)	(0.00598)
4th wealth quantile	0.0390***	-0.387***	0.801***
	(0.00790)	(0.00772)	(0.00460)
5th wealth quantile	0.0433***	-0.544***	0.950***
(1st wealth quintile=Ref)	(0.00844)	(0.00745)	(0.00229)
urban	0.00563	-0.0225***	0.0262***
	(0.00547)	(0.00629)	(0.00793)
Punjab	-0.0395***	0.470***	0.0148
	(0.00629)	(0.00536)	(0.00974)
Sindh	0.00692	0.553***	0.0755***
	(0.00717)	(0.00612)	(0.0110)
Balochistan	-0.148***	0.218***	0.0403***
	(0.0391)	(0.00841)	(0.0147)

(Khyber Pakhtunkhwa=Ref)			
Observations	48,968	48,968	48,928

Average marginal effects are reported. Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The coefficient of head gender for both sensitivity index and composite vulnerability index indicates that male head are less vulnerable in terms of both health vulnerabilities and total vulnerability, as compared to female household head. Moreover household size is positively associated with both types of vulnerabilities indicating increase in household size results in increased vulnerability. Similarly with adaptive capacity the household size is negatively associated. Being married is positively associated with both sensitivity index and total vulnerability, however the adaptive capacity is negatively associated with married individuals.

When we look at age categories, we find that with increase in age both the sensitivity and composite vulnerability index increases, and the most aged individuals of 80 and above are highly vulnerable. Similarly the adaptive capacity is decreased with increase in age.

The sensitivity index and total vulnerability is positively associated with low level of education, while as the level of education increases, the vulnerability decreases significantly. The wealth quintiles show that increase in wealth(by quintiles) results significantly increase in sensitivity index which means that wealthy individuals have higher health expenditures and so have higher adaptive capacity, as compared to those who belong to poor wealth quintiles. It validates the study by Dormont, B et al., (2008) which states that individuals who need more of health care (poor class) are getting less of it. The composite vulnerability is negatively associated with wealth quintiles showing their resilience against covariate shocks. The urban residents have higher sensitivity index as compared to rural showing their increased expenditures in health care and on visits to hospitals. However the total vulnerability of urban residents is lower, which reveals that rural residents are more prone to covariate shocks (climate related shocks). Also the urban residents have higher adaptive capacity as compared to rural.

On average Punjab and Balochistan have lower sensitivity index as compared to Khyber Pakhtunkhwa, while Sindh has highest total vulnerability index than other provinces. Sindh has highest adaptive capacity, followed by Punjab.

To sum up, things are different for old age individuals: the vulnerability of old age individuals is higher as compared to younger age groups. And the urban residents are vulnerable to sensitivity index showing their fluctuating health conditions while those residing in rural areas are more susceptible to covariate shocks. Females are reported as more vulnerable as compared to male and also the male household head have higher adaptive capacity. Among other reasons, the income inequalities on gender basis can be a reason that validates our results.

Discussion

Accurate estimates of the extent of elderly vulnerability are crucial for effective policymaking. The gaps in providing socio-economic protection to the elderly in Pakistan may result from a failure to address the multidimensional nature of vulnerability in old age. This study constructed a vulnerability index using household structure, family size, and financial independence to explore the various dimensions of vulnerability experienced by the elderly. Principal Component Analysis (PCA) was employed to select relevant indicators, which were then used to calculate the index. The findings show that vulnerability increases with age in both rural and urban areas, as captured by the vulnerability index.

The results indicate that elderly women are particularly susceptible to socioeconomic vulnerability, especially due to their financial dependence (Chen et al., 2018). The wealth index significantly impacts vulnerability, as adaptive capacity increases with wealth. Medical expenditures have a strong effect on old age vulnerability, which can be linked to low levels of education and household earnings (Govindasamy, 1997). Reduced income and rising healthcare costs can lead to increased poverty (Lloyd, 2000). The analysis also highlights significant provincial differences. Older adults in Sindh are the most sensitive, which reflects inequalities in access to healthcare, despite higher adaptive capacity among wealthier individuals. The study also finds a negative relationship

between vulnerability and education, as lower levels of education reduce earning potential and wealth accumulation in old age (Girshina, 2019). As evident, vulnerability increases with advancing age.

Conclusion

The evidence shows that vulnerability is a multidimensional construct that has important implications for the economic independence and well-being of the elderly (Oviedo & Czeresnia, 2015). While the government of Pakistan has made efforts to provide social protection to the elderly, these policies are often criticized for their inability to properly identify beneficiaries or meet their needs. The literature mainly considers income as determinant and overlook the multidimensional nature of vulnerability, which can result in financial insecurity for the elderly.

The findings of this study suggest several policy recommendations: First, old age vulnerability should be addressed using multi-dimensional index that includes economic independence, family size and structure, and out-of-pocket healthcare expenses, as these factors together offer a more inclusive picture of vulnerability. Second, protection schemes should include elderly individuals from all age categories, especially women, since the results show that those aged 80 and above and those without education are highly dependent on family support. This is essential for evaluating the success of old age protection policies and aligning them with international models of social transition.

However, the study does have some limitations. It only used data from the 2018-19 round of the Household Integrated Economic Survey (HIES) due to the availability of out-of-pocket expenditure data, which was not published in earlier rounds. Future research could apply similar methods to panel data from future HIES surveys. Additionally, the study was unable to explore the impact of social networks on socioeconomic vulnerability due to data constraints. Lastly, it did not assess the vulnerability of elderly individuals living in old-age homes, so future studies could compare vulnerability across different living arrangements.

Appendix:

Table1: Detailed description of variables and indicators:

	Indicators	Variables description and rationale	Unit
Exposure The chance of occurring covariate shock	Weather and climatic variables	The paper has used weather and climate related data from Pakistan Metrological department (PMD).	
	Negative rainfall shock	It is the deviation of rainfall from lower bound CI from ten years average of monthly rainfall.	mm
	Positive rainfall shock	It is deviation of rainfall from upper bond of CI from ten years average of monthly rainfall.	mm
	Temperature shock	The temperature data consist of mean deviation of maximum temperature (thirty years)	°C
Sensitivity Health related data gathered from out of pocket expenditures part of HIES 2018-19.	Chronic diseases	A binary variable constructed to check for prevalence of chronic disease or not.	Binary
	Total expenditures of availing medical facility	The total expenditures incurred by an individual to a doctor visit including doctor's fee and medicines etc.	Continuous variable
	Hospital visits	Visit to a private or public sector health institute by individual.	Binary
Adaptive capacity Resilience of a household to idiosyncratic or covariate shock	Wealth Index	Construction of wealth index consist of household movable and imovable assets including agriculture land, livestock and housing characteristics and other assets.	Binary

	Literacy rate	The cumulative years of schooling by household's head is defined as household's literacy (Ibok O.W. et.al, 2019). A categorical variable ranging from no education to highest level of education attained is constructed from HIES 2018-19 data to be used as educational level of individuals.	Years

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